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The AVO to EURO-VO Transition

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Abstract. The Astrophysical Virtual Observatory (AVO) initiative, jointly funded by the European Commission and six European organisations, had the task of creating the foundations of a regional scale infrastructure by conducting a research and demonstration programme on the VO scientific requirements and necessary technologies. The AVO project is now formally concluded. I highlight AVO's main achievements and then describe its successor, the EURO-VO project. With its three new interlinked structures, the Data Centre Alliance, the Facility Centre, and the Technology Centre, the EURO-VO is the logical next step for the deployment of an operational VO in Europe.

1. Introduction

The Virtual Observatory (VO) is an innovative, evolving system, which will allow users to interrogate multiple data centres and services in a seamless and transparent way, to best utilise astronomical data. The main goal of the VO is to enable new science by making the huge amount of data presently on-hand easily accessible to astronomers. Within the VO, data analysis tools and models, appropriate to deal also with large data volumes, will be made more available as well. The VO initiative is a global collaboration of the world's astronomical communities under the auspices of the recently formed International Virtual Observatory Alliance (IVOA[1]).

2. The Astrophysical Virtual Observatory

The status of the VO in Europe is very good. In addition to seven national VO projects members of the IVOA, the European funded collaborative Astrophysical Virtual Observatory (AVO) project had the task of creating the foundations of a regional scale infrastructure by conducting a research and demonstration programme on the VO scientific requirements and necessary technologies. The AVO was jointly funded by the Fifth Framework Programme [FP5] of the European Commission with six European organisations (ESO, the European Space Agency [ESA], AstroGrid, the Centre de Données astronomique de Strasbourg

[1] http://ivoa.net

[CDS], TERAPIX, and Jodrell Bank) participating in a three year, Phase-A programme.

The AVO project was driven by a strategy of regular scientific demonstrations of VO technology and is now formally concluded. AVO's main achievements can be thus summarised:

1. *Three science demonstrations.* These were held on an annual basis, in coordination with the IVOA, for the AVO Science Working Group (SWG), established to provide scientific advice to the project. Three very successful demonstrations were held in January 2003 (Jodrell Bank), 2004 (ESO, Garching), and 2005 (ESAC, Madrid).
2. *First VO paper.* I reported last year (Padovani 2005) on AVO's second demonstration, held in January 2004 at ESO, which lead to the discovery of 31 new optically faint, obscured quasar candidates (the so-called QSO 2) in the two Great Observatories Origins Deep Survey (GOODS) fields. These results led to the publication of the first refereed astronomical paper enabled via end-to-end use of VO tools and systems (Padovani et al. 2004).
3. *Science Reference Mission.* The Science Reference Mission is a definition of the key scientific results that the full-fledged VO in Europe should achieve when fully implemented. It consists of a number of science cases, with related requirements, against which the success of the operational VO in Europe will be measured. It was put together by the AVO SWG.
4. *VO tools.* Progressively more complex AVO demonstrators have been constructed. The current one is an evolution of Aladin, developed at CDS, and has become a set of various software components, provided by AVO and international partners, which allows relatively easy access to remote data sets (images and spectra), manipulation of image and catalogue data, and remote calculations in a fashion similar to remote computing. The AVO prototype is a VO tool which can be used now for the day-to-day work of astronomers and can be downloaded from the AVO Web site as a Java application. We note that this is by definition a prototype and will not be maintained on the long term. Most of the functionalities developed for the AVO demonstrations are now available in the public version of Aladin, and the inclusion of the remaining ones is being assessed.
5. *VO development.* AVO provided fundamental input to the IVOA for the development and the usage of the following VO standards: VOTable, Data Access Layer, Data Model, Uniform Content Descriptor, and Web Services.
6. *Creation of IVOA.* AVO has been one of the founding member of the IVOA.

Links to various documents and to the software download page can be found at `http://www.euro-vo.org/twiki/bin/view/Avo/`.

3. The EURO-VO

The EURO-VO work program is the logical next step from AVO as a Phase-B deployment of an operational VO in Europe (see Hanisch 2006 for similar transitional activities in other VO projects). Building on the development experience gained within the AVO Project, in coordination with the European astronomical infrastructural networks OPTICON and RADIONET, and through membership and support of the IVOA, EURO-VO will seek to obtain the following objectives:

1. technology take-up and full VO compliant data and resource provision by astronomical data centres in Europe;
2. support to the scientific community to utilise the new VO infrastructure through dissemination, workshops, project support, and VO facility-wide resources and services;
3. building of an operational VO infrastructure in response to new scientific challenges via development and refinement of VO components, assessment of new technologies, design of new components and their implementation.

EURO-VO is open to all European astronomical data centres. Initial partners include ESO, the European Space Agency, and six national funding agencies, with their respective VO nodes: Istituto Nazionale di Astrofisica (INAF, Italy), Institut National des Sciences de l'Univers (INSU, France), Instituto Nacional de Tecnica Aeroespacial (INTA, Spain), Nederlandse Onderzoekschool voor Astronomie (NOVA, Netherlands), Particle Physics and Astronomy Research Council (PPARC, UK), and Rates Deutscher Sternwarten (RDS, Germany). The total planned EURO-VO resources sum up to approximately 60 persons/yr over three years, i.e., about three times those of the AVO.

EURO-VO will seek to obtain its objectives by establishing three new interlinked structures:

1. the EURO-VO Data Centre Alliance (DCA), an alliance of European data centres who will populate the EURO-VO with data, provide the physical storage and computational fabric and who will publish data, metadata and services to the EURO-VO using VO technologies;
2. the EURO-VO Facility Centre (VOFC), an organisation that provides the EURO-VO with a centralised registry for resources, standards and certification mechanisms as well as community support for VO technology take-up and dissemination and scientific program support using VO technologies and resources;
3. the EURO-VO Technology Centre (VOTC), a distributed organisation that coordinates a set of research and development projects on the advancement of VO technology, systems and tools in response to scientific and community requirements.

The DCA will be a persistent alliance of data centre communities represented at a national level. Through membership in the DCA, a nation's community of data curators and service providers will be represented in a forum that will facilitate the take-up of VO standards, share best practice for data providers, consolidate operational requirements for VO-enabled tools and systems and enable the identification of scientific requirements from programs of strategic national interest that require VO technologies and services. Funds for the DCA have been requested in an FP6 proposal submitted in September 2005.

The VOFC will provide a "public face" to the EURO-VO. Through outreach, support of VO-enabled science projects in the community, workshops and schools, the VOFC will represent a central support structure to facilitate the broad take-up of VO tools by the community. The VOFC will also support the EURO-VO Science Advisory Committee (SAC) to ensure appropriate and effective scientific guidance from the community of leading researchers outside the mainstream VO projects. The SAC will provide an up-to-date stream of high-level science requirements to the EURO-VO. The VOFC will further pro-

vide central services to the DCA for resource registry, metadata standards and EURO-VO access. Funding for the VOFC has yet to be fully defined but will come initially from ESO and ESA with activities ramping up in 2006. The first VOFC activity was the organisation of the EURO-VO workshop[2] at ESO Headquarters in Garching from June 27 to July 1, 2005.

The VOTC will consist of a series of coordinated technology research and development projects conducted in a distributed manner across the member organisations. The first project under the VOTC is the VO-TECH project[3] (Walton et al. 2006), funded through the EC FP6 Proposal and contributions from the Universities of Edinburgh, Leicester, and Cambridge in the United Kingdom, ESO, CNRS and Université Louis Pasteur (France), and INAF (Italy). Additional projects can be brought to the VOTC via other member organisations; one such example is ESA-VO. The VOTC provides a mechanism to coordinate and share technological developments, a channel for DCA and VOFC requirements to be addressed and for technological developments to be distributed to the community of data centres and individual scientists in a coordinated and effective manner.

The EURO-VO project will be proactive in reaching out to European astronomers. The EURO-VO has also started making regular appearances at Joint European and National Astronomy Meetings (JENAM), as of the one in Liege in July 2005. Moreover, the EURO-VO will also help data centres beyond the partners' countries to join the VO effort.

As an example of partners' involvement, I note that on November 1, 2004, the Data Management and Operations Division at ESO has created the Virtual Observatory Systems (VOS) Department. VOS' role is to manage ESO's VO activities and to make its Science Archive Facility into a powerful scientific resource for the ESO community by creating, ingesting, and publishing advanced data products, that is high-level (or "science-grade") data (Rosati 2006).

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[2]http://wwww.euro-vo.org/workshop2005

[3]http://eurovotech.org